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ABSTRACT

Students who have the necessary computational skills can solve word problems in mathematics only if they can comprehend the language of the problem. In order to best teach reading comprehension of mathematical word problems, teachers should consider the following steps: (1) prepare for teaching a problem by analyzing the ways the problem can be solved correctly, and identifying the words in the problem which suggest that process; (2) give the students guided practice in solving a sample word problem by letting them see, step by step, how the problem can be solved; and (3) involve students in problem solving by asking them to supply some of the answers and then gradually release them from direct instruction until they can solve the problems completely on their own. (A sample word problem illustrating these three steps is included.) (SRT)

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READING FOR STORY PROBLEM COMPREHENSION

In 1977 the Second Assessment of National Educational Progress noted a decline in math problem solving ability. In 1983 the Third Assessment of NEP reported very little change in problem solving ability. With the availability of inexpensive calculators to all, selecting the correct process, estimating and/or recognizing the reasonable answer becomes more important than the computational skills themselves in solving problems. These skills depend upon verbal reasoning or inferential awareness that can be directly taught. Consider the following problems.

1."An army bus holds 36 soldiers.
If 1128 soldiers are being bussed
to their training site, how many buses are needed?"
(Carpenter 1983)

In problem taken from the 1983 NEP approximately 70% of the students performed the correct calculations, but 29% gave the exact quotient, and another 18% ignored the remainder.(Carpenter 1983)

Assuming the student has the necessary commputational skills and/or a calculator, he can answer the preceding question correctly or reasonably only if he comprehends certain facts within the problems. These facts are found in words and phrases often taken for granted by the teacher. "Buses" in problem one would be a key word or fact.

Guided practice in inference awareness (metacognitive strategies) depends on the willingness of the teacher to analyze many word problem for the keys to understanding.

STEP I: TEACHER PREPARATION

Look back at problem #1. Ask yourself what's so wrong or funny about a decimal answer. Do you get a picture of part of a bus. Round down. Do you see 12 men being left on the corner. You're visualizing. A very immportant part of solving story or real llife problems. Ask yourself how you got that picture. Try to select just the necessary words or phrases to work the problem and keep the correct picture. Then use a "cloze" procedure: read the problem using only the words you've chosen as the keys to comprehension.

__ ____ bus holds 36 _____. __ 1128 _____ ___ being bussed __ _____ _____ ____, ___ ____ buses needed?

There is no es on "bus" in the information part of the problem. There is an es on "bus" in the the question section. Plurals and articles (a, an, the) are often major keys to comprehension and must be pointed out and taught. Learning to search them out is important. "being bussed" means the whole 1128 have got to go. "buses needed?" tells us the answer is going to be a number of buses. A fraction of a bus won't work. Likewise rounding down will not transport all 1128.

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Notice soldiers is not really a key. It really doesn't matter what we're loading on to the buses.

Next, the teacher must analyse the ways the problem can be solved correctly and what words tell or imply that process. When a total is known (1128) and the capacity of a part or one is given (36), we can divide the part into the whole to find the number of parts needed. Teaching that concept without visualizing or instructing in the importance or what is being divided may still result in a wrong answer. 31.3 may have no concrete association. Even if it has a vague association or meaning, the students may not know if they have .3 of a man, a group of men, or a bus. Worse yet, they may have no idea what difference it makes. If their math is right how can their answer be wrong? Rounding rules won't work in this problem. The correct answer of 32 can only be reached by what is often called common sense. 32 is the only reasonable answer. The student needs to be taught how you know this.

After looking for the key words, ask if any of these imply math concepts or vocabulary that need to be reviewed. Then think of a way to demonstrate to the class how important the visualizing and labeling are.

STEP II: GUIDED PRACTICE

When teaching students how to read story problems, read the question part first. This is done to demonstrate that story problems are built just the opposite of most paragraphs which begin with a topic and give you the details. Story problems almost always begin with details (not all relevant) and end with the main idea or question. (Reutzel 1983) If we want to know our purpose, we search the end first. (1) Say something like, "How many buses are needed? I guess I'm looking for buses." (2) Draw a bus on the board or line up erasers on the chalk tray and call them buses. (3) Then begin to read the problem from the top. Say "an army bus holds 36" and draw 36 dots in or above your bus. (4)"1128 is the total I have to put on buses. Any time I know a total and how many one holds I can divide to find out how many I need, in this case, how many BUSES I need." (5) "31.3 Oops, I can't drive a third of a bus. What's a third of the seats on a bus? About 12. If I round this down, 12 men men will be left behind. What do I do? I have to get all the men to training. I guess I need 32 buses.

Even though you ask questions out loud do not let students answer. Explain that you are modeling--giving them a chance to see how you figured out the reasonable answer to a story problem.

After selecting a problem and analyzing it, model your reasoning process for the class. Many times the students will see as important something you've overlooked as too obvious. They will help you see how really basic direct instruction needs to be. For example, after I'm sure all my Chapter I junior high studens can identify a rectangle, I ask them to draw one and label the sides with scaled dimensions. Some will draw a perfect rectangle and label opposite sides 5 and 10. Some still draw other shapes. Some draw equilateral triangles and label the sides with 3 different numbers.

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STEP III: GRADUAL RELEASE:

The first step in guided practice is modeling. That must be followed by three more similar problems asking students to supply answers or reasoning followed by work on their own. For example, the second problem might be "A newspaper has 36 pages. If 1128 pages are available, how many newspaper can be made?"

This time the teacher would still read the question first, but would follow that by asking what the answer label will be and what process that seems to call for. (We need a number of papers. Given a total number of pages available and the part or number that must be put in groups called newspapers, it appears we will divide.) Now the teacher agrees and pulls out the evidence, key words, for the class in the same way as in number one. Then asks a student to explain why or if that seems reasonable. Why is this answer 31 not 32?

The third time through alternate the questions asked and information given. "A newspapers has 36 pages. If 1128 newspapers are needed, how many pages will be used." This time the teacher reads the question, surveys or reads the whole problem and gives the answer. We are looking for a total number of pages used. I would multiply. I may or may not give the correct numerical answer. "Holy cow, I'll need 40,608 pages." Now the student must provide the evidence for my conclusions and respond to the reasoning involved. It is an excellent time to discuss why you would expect this answer not only to be large but to be roughly around 40,000.

On a fourth example the teacher does nothing more than reading the question first? "A chef needs one pint of mix to make 36 servings of punch. If 1128 servings are needed, how many pints of mix will he need." The students must respond with what process seems to be called for, what the label will be on the answer, what key words seem to tell us that and whether or not that seems reasonable.

Note that each problem contained the same numbers and three of the four involved the same process, Yet, because of comprehension key words like buses, papers, and mix, the correct numerical answers were 32, 31, and 31.3. When the concept changed to pages (parts in a whole) the answer was 40,608.

Finding the answer here means finding the answer to the comprehension question. What is the label? What is the process? Can the answer have a decimal? Does that make sense? Why or why not? Therefore you could teach every problem in your text in this detail and still give the same problems as homework for the correct numerical answer.

The above process should be repeated with each new chapter, concept, and process that is introduced. Also concepts must be reviewed and mixed. Students must have practice discerning one process from another. Endless problems on one concept do nothing to teach process selection. As ideas are introduced mix them with those previously taught.

How do you know if they're using inference awareness on their own? There are a number of ways to check. The number right is the simplest check. Give extra points for drawings or underlining words. One especially useful technique is having them label with complete

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sentences. "It will take 32 buses to transport all 1128 soldiers." Give one point for each correct sentence and one for each numerical answer. The most important check comes when a new concept occurs and students demonstrate some skill at working through on their own to a reasonable answer instead of asking for help saying, "I don't get it."

In a survey of Chapter I and algebra students in 7th and 8th grade at one junior high it was found that at their respective levels both groups needed this type of instruction in awareness of how to comprehend. At the point where understanding was not automatic neither student had a process for searching and reasoning. The student (algebra or Chapter I) who makes no attempt to answer a certain problem or answers without giving correct labels needs inference awareness instruction. He needs to be directly taught how the teacher reasons through a problem.

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